19 December 1991

Before
The Federal Communications Commission
1919 M Street
Washington, DC 20554

In the Matter of
Advanced Television Systems
and Their Impact on the
Existing Television Broadcast
Service

MM Docket No 87-268

These comments are directed to Paragraph 47: Compatibility with Other Media.

My name is Alan K. McAdams. I am a Professor of Managerial Economics at the Johnson Graduate School of Management of Cornell University and a member of the IEEE, the Institute for Electrical and Electronics Engineers. I chair the Subcommittee on U.S. Technology Leadership of the Committee on Communications and Information Policy (CCIP) of the IEEE-USA and also serve as Vice Chair of CCIP. For the IEEE-USA I have helped organize and chaired or co-chaired several workshops and participated in others on the topic of High Resolution Systems (HRS), the consumer electronics implementation of which is Advanced Television (ATV), also known as High Definition Television (HDTV). I am submitting this comment, however, in my role as private citizen.

First, let me congratulate the Commission for its foresight in considering the path-breaking approach to standards facilitation implicit in the effort to assure compatibility of ATV transmissions with other forms of transmission and applications. I strongly endorse this objective. Success in such an effort can provide substantial economic, educational, and social benefits both in this country and internationally.

From extensive discussion of the matters addressed in MM Docket No 87-268, I have come to a number of understandings as set forth in succeeding paragraphs, and offer them to aid the Commission as it comes to grips the issues before it. My initial acquaintance with the main outlines of an architecture such as that addressed below, came from a paper delivered by Professor Tennenhouse of MIT.

Key elements of an architecture through which a high resolution image such as that from an ATV broadcast can become interoperable across applications and industries include :

* scalability,

* extensibility,

* modularity and the decoupling of stages:

* abstract digital representation of elements of the visual image, and

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* very simple subsetting of the characteristics of the image.

As discussed below, these elements are interrelated.

"**Scalability**" refers to the ability of the architecture to permit multiple variants of an image to exist at a given point in time so that it can be used by multiple media. For example, a given HRS presentation might simultaneously be capable of being presented through three different media: a large movie screen, a home television receiver and a futuristic video wristwatch. The resolution of the image presented in each respective case need not be the same. The greatest resolution would be required by the movie screen, the least by the wristwatch. Other characteristics of the presentation of the image also might differ in each case. For example, if the image being received happened to be that of the opera, "Carmen," the presentation on the movie screen might be the entire stage. The presentation on the home receiver might be of action at center stage, while the presentation on the wristwatch might focus on the image of the soloist.

"Scalability" as a characteristic of an architecture implies the ability of the architecture to permit all those attributes necessary to each respective display medium simultaneously to be available.

"**Extensibility**" implies the ability of the given architecture to be adapted to rapid technological advance; its design must anticipate rapid technological change. An alternative term for this characteristic might be "technological transparency," the ability of the architecture to accomodate changes in technology as they arise.

Initial research is already going forward to deal with transfer rates for data and images involving tera-bits -- quadrillions of bits -- per second. Any standard adopted today must anticipate a rate of technological change leading to such speeds; there can be no permanent upper-bound on such parameters as these. Rather, at the time a given set of parameters within the architecture is specified, the next logical points at which to specify sets of enhanced parameters must also be tentatively identified.

The twin objectives of such an architectural approach are: 1) to anticipate what is already known about the future, and 2) to provide sufficient flexibility in the architecture so as to be able later to incorporate what cannot be yet known. For example -- and these parameters are illustrative only -- it is already known that pen and ink on white paper have a resolution that can be approximated electronically on a screen through 8,000 verticle lines at approximately 60 frames a second, progressively scanned. Equipment to provide this level of resolution is not currently available at reasonable cost. However, user needs for such a level of resolution are readily identifiable; this level of image resolution is likely to be available economically at some time in the not too distant future. Also, many workstations today have 2,000 vertical lines and are progressively scanned at 72 frames per second, a level of resolution that does exist today at a reasonable cost for current applications. Unfortunately and as is well known, the brightness of the image and the color scales available for workstation displays within these cost parameters are inappropriate for the creation of economical home video receivers. Yet it is not inconceivable that they soon could be. Technological improvements and cost reductions from economies of scale and economies of learning-by-doing might make this possible, even within a decade. At the moment it appears that the capture of visual images through 800 lines of progressive scanning at 60 frames per second is economically feasible for the home.

Given the facts assumed in this illustration, any standards set today would have to be extensible from 800 to 2,000 or to even 10,000 lines. The timing of the detailed specification of the parameters appropriate to the more advanced stages is at present not knowable. Nonetheless, it is possible already to identify a number of the rough parameters which must be present simultaneously in order for each of these thresholds of image resolution not to be foreclosed.

<u>Modularity and the Decoupling of Stages</u>: The multiple stages in the process of development of HRS signals are suggested below, with extra emphasis on the liklihood that different forms of storage will be necessary between stages:

capture
    storage

production/post production
    storage

transmission
    storage

display
    storage

Each of these stages can be achieved through multiple approaches. For example, transmission mechanisms include terrestrial broadcast, as is the case with this proceeding; coaxial cable; fiber optic cable; fixed satellite service; broadcast satellite; and VCR. The objective of decoupling each of the stages has, to some extent, already been achieved (except for live broadcast). For example, when international exchange of a given visual image is anticipated today, capture is likely to be through film. This permits the decoupling of the capture from the transmission stage. Transmission in the United States currently is through equipment built to NTSC standards. The transcoding from film to electronic tape is now a routine, well-understood, reasonably inexpensive process. Similarly, transcoding into PAL for European transmission can be quickly and easily achieved from the medium of film. Production and post-production also have been significantly decoupled. Even when production is through the film medium, post production with its special effects is likely to be achieved electronically through computer simulation and visualization.

It is likely that the rate of technological change will be different for each step in the process. Decoupling of the various stages permits a modular approach; it will be possible to make improvements at each respective step when the technology is right for improvement at that step.

Under the type of, architecture proposed, it would be possible to specify the parameters which applied at the time of capture of an image, those which were modified through the production process, those that were introduced at the post-production stage, those that correspond to the intended transmission medium, those which identify the display media that are supported, as well as those that identify the storage media that are supported. Once again, the virtually infinite combination of attributes which this procedure implies must be reduced through mutually agreed pre-established **<u>very simple subsetting</u>**. Each of the very simple subsets must be identified with an equally simple **<u>abstract digital representation</u>**. In other words, a "standard" would represent agreement on what each of the elements in the process represents, as well as on the abstract representation for that element.

<u>Implementation of the Architecture: A Discussion</u>

As just suggested, the implementation of an architecture of this kind would require that the representation of an image would embody not just the image itself, but also, the abstract digital representation of how the image was captured and what transformations had been made to that image. With such information a user would be able not only to present the image, but also to elect to accept only some of the various transformations of that image.

If, for example, in a given video-watch display a producer were to conclude that a "group shot" was preferable to a close-up of the principal performer, and that producer recognized that the "existing simple subset" for home receiver display included the group-shot, he or she could insert a command which would bring about a shift to the group shot. This change could be made to apply only to the video-watch, or in different circumstances it might be incorporated for all forms of display. The reader may note that an architecture of this kind could be adapted to permit interaction by the viewer. The viewer with a home receiver could be empowered to select the close-up known to be simultaneously available to the video-watch viewer.

It must be noted also that limitations at the capture stage may well foreclose the achievement of goals otherwise desirable at a later stage. For example, capture of images through electronic cameras built to NTSC standards cannot support resolution beyond the information available from 525 lines at 60 fields of interlaced scanning per second (the information in a "field" is equivalent to half that in a "frame;" two interlaced fields are required to create a frame). Nonetheless, it may be possible through computer enhancements to provide more desirable presentation of whatever information was captured.

A second element of the scalability concept is implied in a "family" of parameters which might accord with different applications. For example, 72-75 frames of progressive scanning for live sports presentations might be consistent with 24-25 frames of progressive scanning for higher resolution film capture.

The use of such an architecture would represent a sharp contrast to the approaches of the past. To implement it properly would require, as one element, the labeling of the image in a standard format through what experts have come to call the "header, descriptor" portion of the signal to codify the abstract digital representation and very simple subsetting.

Let me again express my admiration for the foresight that this Commission has shown in coming to grips with this path breaking approach to standards facilitation for our modern era of fast moving technological change. I strongly endorse the objective of assuring compatibility of ATV transmissions with other forms of transmission and applications. As stated above, success in such an effort can provide substantial economic, educational, and social benefits both in this country and internationally.

Respectfully Submitted,

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